



MARKSCHEME

May 2013

BIOLOGY

Higher Level

Paper 3

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Subject Details: Biology HL Paper 3 Markscheme

Mark Allocation

Candidates are required to answer questions from **TWO** of the Options [**2 % 20 marks**].

Maximum total = [**40 marks**]

1. A markscheme often has more marking points than the total allows. This is intentional.
2. Each marking point has a separate line and the end is shown by means of a semicolon (;).
3. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.
4. Words in brackets () in the markscheme are not necessary to gain the mark.
5. Words that are underlined are essential for the mark.
6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.
7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by **OWTTE** (or words to that effect).
8. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.
9. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking indicate this by adding **ECF** (error carried forward) on the script.
10. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the markscheme.

Option D — Evolution

- D1.** (a) both (histidine and glycine) show catalytic activity;
histidine more effective/greater % yield than glycine (after 4/7 cycles);
glycine more effective (than histidine) after 1 cycle;
effectiveness of glycine decreases after 4 cycles whereas of histidine remains high; [3 max]
- (b) salt used to mimic conditions in the oceans;
evaporation cycles reflect conditions in shallow lagoons/pools/intertidal zones;
high temperature expected on prebiotic earth;
atmosphere in chamber is anoxic/lacks oxygen;
biomolecule concentrations can increase (since oxygen/life forms are absent); [3 max]
- (c) abiotic synthesis of organic molecules in atmosphere;
at hydrothermal/deep sea vents in ocean floor; *(do not accept volcanoes)*
extra-terrestrial origin of organic molecules / comets contain a variety of organic compounds;
evidence for water elsewhere in solar system;
clay particles act as replication platform/catalyst for formation of biomolecules;
hot springs; [2 max]
Do not accept primordial soup as that is what is described in the question.
- D2.** (a) large population;
randomly breeding population;
no mutation;
no selection (for an allele);
no migration/immigration or emigration; [2 max]
- (b) initially isolated populations may have been genetically different/different allele frequencies;
different mutations in two gene pools;
different parts of population subject to different selective pressures / *OWTTE*;
over time leads to changes in allele/gene frequencies;
may lead to reproductive isolation; [2 max]
- (c) cultural evolution can be passed down by non-relatives in community whereas genetic evolution cannot/is inherited;
genetic evolution requires changes to the genetic information/allele frequencies whereas cultural evolution does not/can be acquired knowledge;
cultural evolution can happen in the lifespan of an individual/rapidly whereas genetic evolution takes generations/is slow; [2 max]

- D3.** a cladogram is a diagram which shows shared characteristics/phylogenetic relationships;
phylogeny is the study of evolutionary origins/ancestry;
clade is a group of (all) organisms that evolved from a common ancestor;
evidence from biomolecules/DNA/RNA/protein/cytochromes;
cladograms can be compared with other representations of phylogenetic relationships/may confirm fossil/anatomical evidence;
organisms placed close together in a cladogram are closely related evolutionarily;
there may be more than one possible cladogram (for a particular group) raising questions about evolutionary relationships;
divisions between clades/nodes suggest the sequence in which groups diverged;
cladograms can be used to estimate time since groups diverged;
cladograms are often similar to classification based on other evidence/traditional methods;
cladograms may lead/have led to reclassification of a group;

[6 max]

Option E — Neurobiology and behaviour

- E1.** (a) spring, green light **[1]**
Both required for [1].
- (b) in green light birds migrate North in spring but South in autumn;
in red light birds orientate (North) West in both autumn and spring; **[2]**
- (c) in red light birds do not migrate in the normal pattern/direction;
red light disorientates the birds/interferes with the functioning of
magnetoreceptors;
red light has (almost) the same effect as total darkness / birds do not see in red
light; **[1 max]**
- (d) during daytime;
direction of migration is not normal/wrong orientation in darkness; **[2]**
- (e) no effect;
may become (even) more random; **[1 max]**
- E2.** (a) I iris
II vitreous humour
III choroid
IV fovea (*do not accept yellow spot*) **[2]**
Award [1] for every two correct answers.
- (b) pupil normally constricts when light is shone on it;
light detected in the retina and impulse sent to brain;
lack of (motor) response indicates no brain processing taking place/brain death; **[2 max]**
- (c) dopamine initiates depolarization of post-synaptic membrane;
cocaine binds to (transporter) carrier proteins/proteins in pre-synaptic membrane;
cocaine blocks reabsorption (of dopamine);
cocaine causes dopamine build up in synaptic cleft/space;
so stimulus continues/cocaine is excitatory; **[3 max]**

- E3.** behavior that benefits other individuals and is/may be harmful to self;
increases survival of colony/species as a whole, not individuals;
natural selection works at the level of gene pools/level of the colony/population;
would normally expect natural selection to work against behavior that reduces chance of survival/reproduction;
common in animals with complex social structures;
individuals care for related individuals who are not their own offspring;
named example of altruism towards related individuals (*eg* in naked mole rat colony non-breeding animals help to raise offspring/forage for food/clean nest/defend); *Do not accept name of animal alone, but show briefly what the altruistic behaviour is.*
individual that is helped may be a relative/share genes/kin selection;
difficult to explain altruism towards unrelated/genetically distant individuals;
named example of altruism towards unrelated individuals (*eg* vampire bats share regurgitated blood with another colony member who has not fed);

[6 max]

Option F — Microbes and biotechnology

- F1.** (a) 53 mg dm^{-3} [1]
Accept answers in the range 51 to 54 (units required).
- (b) BPT3 because it is less inhibited by Cr^{3+} [1]
- (c) Cr^{3+} more toxic than S^{2-} (between concentrations of about 67/70 and 80 mg dm^{-3});
 Cr^{3+} toxicity increases more rapidly with increasing concentration than S^{2-} ;
 Cr^{3+} requires lower concentration to cause same percentage inhibition (between 40 and 70 %) as S^{2-} / vice versa;
below (about) $30 \text{ (mg dm}^{-3})$ Cr^{3+} not toxic whereas S^{2-} effect not known/may be toxic / Cr^{3+} cannot be compared with S^{2-} below concentration of 70/67 (mg dm^{-3}); [2 max]
- (d) denitrifying bacteria convert nitrate to nitrogen/ N_2 ;
nitrate causes eutrophication/algal blooms in rivers / removing nitrate reduces the risk of eutrophication/prevents algal blooms;
high levels of nitrate/algal blooms lead to anoxic conditions / increase BOD / reduces oxygen levels;
nitrate is toxic for humans (in high concentrations);
removing nitrate reduces the risk of nitrate entering drinking water; [3 max]
- F2.** (a) high salinity (halophiles);
example of high salinity (*eg* Dead Sea, Great Salt Lake Utah);
extreme pH (acidophiles/alkalinophiles);
high pressure (barophiles) / deep oceans; [2 max]
- (b) anaerobic fermentation of biomass/manure/suitable biomass material;
bacteria convert biomass into organic acids and alcohol;
bacteria produce CO_2 and H_2 ;
methanogenic bacteria produce methane;
by reducing/reacting CO_2 with hydrogen gas/ $\text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$;
or directly from organic acids/acetate/ $\text{CH}_3\text{COOH} \rightarrow \text{CH}_4 + \text{CO}_2$; [3 max]
Accept suitable word or chemical equations for the last two marking points.
- (c) *Euglena* have a flagellum;
Paramecium have cilia; [2]

- F3.** bioremediation uses bacteria to remove contamination;
suitable bacteria may already be present in the environment;
bacteria may use contaminants in metabolism/as an energy source;
end products (of metabolism) are less toxic than (inorganic) contaminants;
bacteria may concentrate/isolate it within the microbial cells;
can be carried out *in situ* or *ex situ*;
suitable example (eg degradation of solvents / oil spill cleanup / oxidation of selenium /
can be used to deal with pesticides);
second suitable example;
useful bacterial strains obtained by genetic modification;

[6 max]

Option G — Ecology and conservation

- G1.** (a) herbivores (primary consumers) **[1]**
- (b) same range of mercury concentrations/up to 200–250 (ppb);
levels above 50 (ppb) are lower/less common in herbivores than in detritivores /
vice versa;
(0–) 50 (ppb) is most common in herbivores whereas (50–) 100 (ppb) is most
common in detritivores; **[2 max]**
- (c) piscivores feed at different trophic levels (within the food chain);
piscivores that feed on herbivores / detritivores will have lower levels of
contamination;
piscivores that feed on carnivores/omnivores/top of food chain will have high
levels; **[2 max]**
- (d) (recognize that) some fish are more contaminated than others;
identify and eat fish that are close to the start of a food chain;
avoid eating piscivores/omnivores/highly polluted species;
eat only piscivores that feed close to the start of a food chain; **[2 max]**

- G2.** (a) a biome is a geographical region where similar climate conditions give rise to similar vegetation (whereas) the biosphere refers to all areas of the Earth (atmosphere, hydrosphere, lithosphere) where living things can be found / OWTTE

[1]

Both parts (biome and biosphere) are needed to award the mark.

(b)

<i>Biome</i>	<i>Temperature</i>	<i>Moisture</i>	<i>Vegetation</i>
tropical rain forest	hot; little fluctuation	wet	evergreen / stratified
desert	variable daily and seasonally / extreme daily variations / some deserts cold and some deserts hot	very dry, very low rainfall/long periods without rain	few/scattered (with bare ground) / xerophytes
savanna	high/little seasonal fluctuations	dry/low rainfall/long dry season	grasses with scattered trees
grassland	cold to warm / seasonal fluctuations	medium dry / moderate rainfall / rainfall seasonal	mainly grasses
broadleaf / deciduous forest	moderate, seasonal variations / cool winters, warm summers	moist/moderate rainfall / rain throughout year	trees with broad leaves/deciduous / trees shed leaves (in winter)
coniferous forest / taïga	low temperatures, seasonal variation / very cold winters, short cool summers	moist / moderate rainfall / irregular rainfall	conifers
tundra	low temperatures / very long cold winters	little precipitation, mainly snow / higher for alpine	herbaceous with lichens and mosses / shrubs / dwarf trees

[3 max]

Points are awarded for temperature, moisture and vegetation.

Award [3] for 8–9 correct points.

Award [2] for 6–7 correct points.

Award [1] for 3–5 correct points.

Award [0] for 2 or fewer correct points.

- (c) nature reserve is a well defined/limited region with a protective framework/legislative protection;
large reserves promote biodiversity more effectively than small reserves;
size must be enough to have a well defined community of organisms;
edge effect is seen at or near the boundary between ecosystems;
leads to differences in population densities/biodiversity/levels of predation in central areas compared to edges;
habitat corridors allow organisms to move between parts of a fragmented ecosystem;
example of habitat corridors such as hedges/canals/drainage channels/tunnels/underpasses/overpasses;

[3 max]

- G3.** oceans are huge ecosystems with no borders / many important fishing grounds are in international waters;
fishing vessels often have a large geographical range / operate outside of national jurisdiction;
marine organisms migrate so need protection across their full range / breeding sites may be distant from feeding grounds so both need to be protected;
agree on maximum sustainable yields/quotas;
apply the precautionary principle in determining the level of exploitation;
agree on allowed fishing sites and exclusion zones;
agree on fishing seasons and moratoriums;
identify and agree on species that may be fished and those that may not;
determine and agree on which fishing methods are allowed and which are not/net and mesh size limitations;

[6 max]

Option H — Further human physiology

- H1.** (a) accept range 3.8–4.2 (%) [1]
- (b) (i) percentage saturation of O₂ drops in both during exercise;
decrease is greater/more rapid in athletes than in non-athletes; [2]
- (ii) athletes exercise more vigorously/at higher intensity;
athletes use more oxygen during exercise; [1 max]
- (c) ventilation rate/tidal volume increased;
more oxygen absorbed (per minute);
heart rate increased; [2 max]
- (d) altitude causes formation of more red blood cells/more haemoglobin so/thus the capacity to carry oxygen increases; *Idea of capacity is essential although can be OWTTE.*
the % saturation of blood is lower because there is less oxygen in the atmosphere; [1 max]
- H2.** (a) peptide hormones do not enter the cell whereas steroid hormones do;
peptide hormones bind to a cell surface receptor whereas steroid hormones bind to a receptor in the cytoplasm;
peptide hormones act through a secondary messenger/cAMP whereas steroid hormones have (direct) effect on DNA;
steroid hormones have effect on gene transcription whereas peptide hormones change activities of cell/influence enzyme activity; [2 max]
- (b) involves both nerve impulses and the hormone gastrin;
sight/smell of food causes nerve impulses to be sent/reflex action;
food in stomach stimulates touch receptors/chemoreceptors/stretchreceptors releasing more gastric juice;
stretching of stomach wall stimulates secretion of the hormone gastrin; [2 max]
- (c) (pepsinogen) secreted by gastric glands/stomach wall;
pepsinogen converted to pepsin/activated by HCl;
autocatalytic reaction / pepsin causes conversion of pepsinogen to more pepsin;
inactive form necessary to prevent damage to stomach wall / self digestion of enzyme-producing cells; [3 max]

- H3.** produces bile for digestion/emulsification of fats/lipids;
regulates blood glucose level through glucose-glycogen reaction;
detoxification/example of detoxification (eg contains catalase for the breakdown of
hydrogen peroxide);
manufactures plasma proteins/albumins/fibrinogen;
manufactures cholesterol;
destroys red blood cells by phagocytosis;
breaks down haemoglobin from red blood cells;
stores iron;
stores vitamin A and D;
deaminates excess amino acids/formation of urea;

[6 max]
